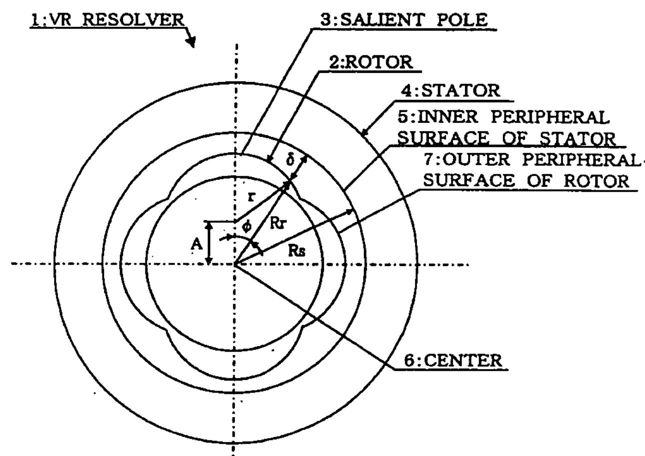
Serial No. 10/821,910

REMARKS

Claims 1-5 are presented for reexamination.

The claims are amended to improve wording and clarity.

Reconsideration of the rejections of the claims under 35 U.S.C. §102(b) and §103(a) based upon U.S. Patents 3,514,316 (Caywood, Jr.), 4,186,316 (Singh) and 5,559,386 (Gurrieri) is requested inasmuch as the prior art fails to disclose or suggest any variable reluctance resolver which has a noncircular rotor 1 of magnetic material with a plurality of salient poles 2 (see FIG. 1) protruding from a central circular portion and wherein each salient pole has a center which is offset by an offset distance A in the radial direction from the center 6 of the rotor and wherein the outer peripheral shape of each salient pole 3 is an arc of a circle of radius r centered on the center of the salient pole. It is noted that the defined structure results in edges of each pole (the ends of each arc), either at the central circular portion of the rotor or at the abutting junction to the adjacent salient pole (FIG. 1), which are abrupt and not smooth in the circumferential direction as taught by the prior art. This prior art requirement is noted particularly in U.S. Patent 4,631,510 (Nagarkatti et al. –



cited in the office action but not applied in the rejections of the claims) at column 2, line 65 through column 3, line 7:

> "The rotor is of either solid or laminated ferromagnetic material and defines a periphery profiled to produce during rotation a *smoothly varying* airgap according to a formula wherein the inverse of the radial airgap at any predetermined point on the rotor is proportional to a constant plus the sine of the product of the number of lobes on the rotor and the angle between the predetermine pont on the rotor and a reference point on the stator. According to this construction, the magnetic permeance of the air gap varies sinusoidally." (Emphasis added.)

As clearly illustrated in applicants' specification, the defined structure in spite of its non-smooth varying air gap results in significantly improved sinusoidal gap permeance properties (see Figs. 4a and 4b and the description on page 14) which are not expected from the teachings of the prior art.

Caywood, Jr. discloses two embodiments of a magnetic reluctance resolver, namely Fig. 2 having a double lobed elliptically shaped magnetic rotor (column 3, lines 27-28) and Fig. 3 having a single lobed magnetic rotor which is circular with an offset axis of rotation (column 5, lines 1-6). Relative to these embodiments, Caywood, Jr. teaches at column 4, lines 54-58:

> "The proper shape of the rotor, as mentioned before, to obtain a sinusoidal variation in carrier current is found to be such that the air gap length (in a radial direction) is in itself a sinusoidally varying function of the angular position."

This sinusoidally varying function of Caywood, Jr. is a "smoothly varying" function contrary to the defined structure of the present claims where the variation in the air gap at positions between adjacent salient poles is neither smooth nor sinusoidal.

The office action applies Fig. 4 of Caywood, Jr. to the claims. Fig. 4 shows two circular cylinders 64 and 65 which "are constructed of electrically conducting material and are completely void of any magnetic material" (column 5, lines 44-49). The effect of a non-magnetic electrically conducting rotor on the magnetic flux emanating radially from the stator poles is substantially different from the effect of a magnetic rotor; non-magnetic electrically conducting material opposes flux changes while magnetic material enhances the magnitude of flux. As stated at column 5, lines 37-38 in Caywood, Jr., conductive material shields and reduces the magnetic field. Caywood, Jr. in the paragraph at column 6, lines 9- 34 states:

> "In operation, the rotor, which is mounted on the shaft, will be caused to rotate within the fixed stator member. A high frequency current energizes the stator windings and sets up a magnetic flux flowing within the magnetic circuit of stator 40. The magnetic flux thus set up will be caused to enter the rotor element as it passes by the adjacent teeth. The amount of magnetic flux passing in and out of the teeth will vary *proportional* to the length of the air gap established between the rotor surface and the stator teeth. As the air gap becomes increasingly small, the flux passing will become increasingly large. On the other hand, as the gap becomes increasingly large, the amount of lux flowing in or out of the adjacent tooth will become increasingly small. Hence, it can be seen that the variation in flux is *inversely proportional* to length of the air gap. As mention previously, the surface of each of the rotors varies sinusoidally with angular displacement about the rotor axis 60. The air gap length therefore, is in itself a sinusoidally varying function of the angular position. The resulting flux variations cause the high frequency carrier wave to be modulated by a true sine wave. The signal output thus developed at 36 in FIG. 1 is modulated in accordance with the sine wave thus imposed on the carrier signal. This modulated signal can be utilized to determine the exact position of the mechanical input shaft." (Emphasis added.)

The statements in lines 16 and 23, "proportional" and "inversely proportional", concerning the variance of flux relative to air gap length appear initially inconsistent. However it appears that the above quoted paragraph applies to all the described embodiments so that

"proportional" applies to the embodiment of Fig. 4 while "inversely proportional" applies to the embodiments of Figs. 2 and 3. This is also consistent with the description in Caywook, Jr. of "shielding" produced by conductors; i.e., when the gap is small, the non-magnetic electrically conductive rotor impedes the changes in flux emanating from the adjacent stator pole; this is opposite to, or at least different from, the magnetic rotor wherein the magnetic properties of the rotor at the small gap position increase the magnitude of the magnetic flux. The embodiment of Fig. 4 expressly excludes a rotor of magnetic material as defined in the present claims and operates in a manner different from the invention describe in the present claims. The teaching in Caywood, Jr. of production of a sinusoidal signal by the shielding provided by the circular conductive cylinders does not lead one skilled in the art to modify the Caywood Jr. magnetic rotor of Fig. 2 to have magnetic lobes of circular arcs which terminate at non-smooth junctions with a central circular portion or an adjacent magnetic lobe, particularly when Caywood, Jr. teaches that the air gap for a magnetic rotor must vary sinusoidally (column 4, lines 55-58), i.e. must be smooth.

Singh discloses a stepping motor with shaped rotor teeth. A stepping motor operates by pulses and it has no relevance to the presently claimed reluctance resolver which produces a highly accurate sinusoidal signal variation without the prior art requirement of continuous sinusoidal varying gap.

Gurrieri discloses a high efficiency salient pole reluctance synchronous motor which has conductive rings in the rotor to improve acceleration and deceleration. This overcomes a

drawback of inadequate initial torque of prior art synchronous reluctance motors. Like Singh the motor structure of Gurrieri has no relevance to the reluctance resolver of the present claims.

Concerning the equations of claims 2-5, there is defined a sinusoidal variation of air gap only through the angle of extent of each pole. At the angular position between adjacent poles, there is a discontinuity or abrupt change in the sinusoidal variation of the air gap. The expressions in column 5 of Caywood, Jr. show that his single lobe rotor formed by an offset circular produce a continuous sinusoidal variation in air gap throughout the complete angular rotation of the rotor; this does not in any manner suggest that a rotor which does not produce a smooth or sinusoidal air gap variation through out its entire range of rotation can produce a sinusoidal variation in magnetic permeance.

It is noted that the rotors of Singh and Gurrieri have abrupt changes in gap variation between adjacent poles. However, there is no suggestion in the prior art that such discontinuities in rotor radius of any stepping motor or any synchronous reluctance motor could result a sinusoidal variation in magnetic permeance in a reluctance resolver. A stepping motor is operated by pulses and thus has no relevance to production of sinusoidal signals in a reluctance resolver. Although a synchronous reluctance motor is driven by sinusoidal signals, the solution to the problem of inadequate torque proposed by Gurrieri has no relevance to the production of sinusoidal signals by a reluctance resolver. Thus one skilled in the art is not

lead to modify the teachings of Caywood, Jr.by the teachings of the stepping motor of Singh or the teachings of the synchronous reluctance motor of Gurrieri.

The application as now amended is believed to be in condition for allowance and such favorable action is requested.

Respectfully submitted,

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